MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

TDS3651 – VISUAL INFORMATION PROCESSING
(All sections / Groups)

17 OCTOBER 2018
2:30 p.m. – 4:30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the **Answer Booklet** provided.

Question 1

a) You have an 8-bit RGB image (24-bit in total) of resolution 800x600 pixels. What is the size of the image file in MB?

[2 marks]

b) A grayscale image has the following histogram:
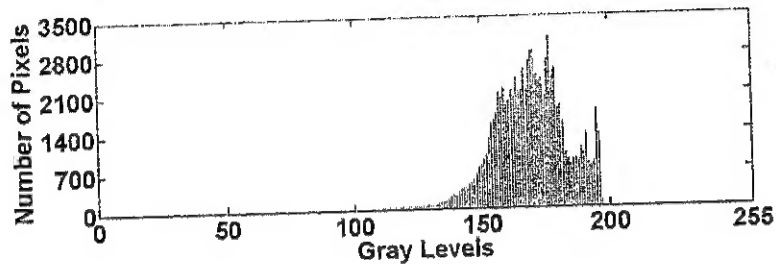
i) What is the problem with the exposure quality of the above image?

[1 mark]

ii) Name two image processing techniques that can be used to enhance the image above.

[1 mark]

iii) Can two different images have the same histogram? Explain your answer and give an example of the two different images.

[3 marks]

c) The filtering process modifies the value of a pixel $f(x,y)$ based on a small neighbourhood of pixels surrounding it. **Median filter** is effective for removing spikes such as salt & pepper noise. Sketch the result when a 3x3 median filter is applied to the grayscale image below. You only need to compute the values for the central region of the image that is fully covered by the mask.

| 0	3	2	6	1
6	4	7	6	1
5	6	1	7	5
1	4	0	7	6
1	6	2	1	5

[3 marks]

Continued...

Question 2

a) Name and briefly describe two criteria of an **optimal edge detector.**

[2 marks]

b) Morphological operation changes the shape of the foreground regions via intersection/union operations between a scanning structuring element and binary image. Two basic morphological operations are dilation and erosion.

The image D below can be generated from F using a dilation or erosion operation followed by a second dilation or erosion. Assume H_1 and H_2 are morphological operators (dilation or erosion), where the size of the structuring element is 3x3. Ignore the border pixels. Specify the two morphology operations, H_1 and H_2, and draw the resulting intermediate image, I after the first operation.

Input image F $\xrightarrow{H_1}$ Image I $\xrightarrow{H_2}$ Desired image D
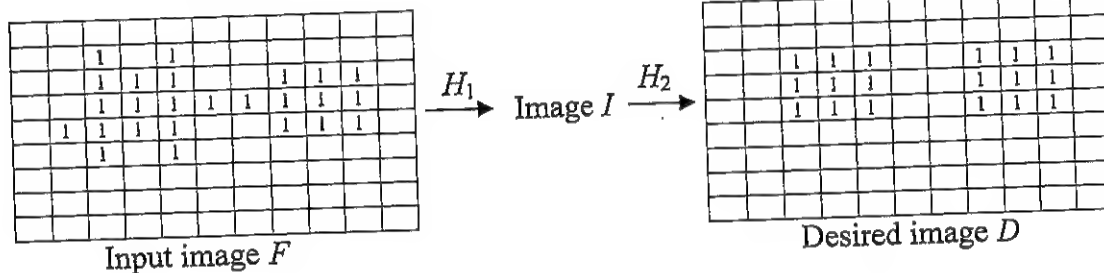
[3 marks]

c) Given below is a binary image where dark pixels denote object pixels.
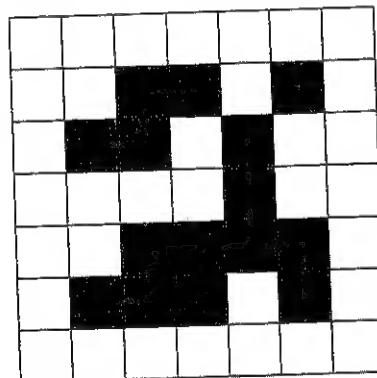
Use **4-connectedness** to label the distinct objects in the binary image. Use '0' for background pixels, and non-zero integers for the labelled regions
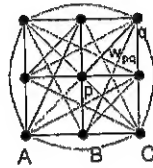
[3 marks]

d) **Chromaticity** is a property related to the perceived color or "chroma". Name and briefly describe the **channel(s) in the HSV color space** that represents the chromaticity?

[2 marks]

Continued...

Question 3

a) Segmentation aims to obtain an intermediate representation that compactly describes key image/video parts. A popular approach to image segmentation is graph cut, where the image segmentation problem is modeled as an energy minimization problem with a grid graph. Each node in the graph represents a pixel. The diagram below illustrates a simple graph representing a small subset of the pixels in an image, along with a sample segmentation result obtained with graph cut.

Describe in a few precise steps how the graph cut algorithm break or cut the graph into segments.

[3 marks]

b) SIFT is robust local invariant descriptor. In a nutshell, SIFT descriptors are formed by first detecting the key points in an image and for each key point, a local descriptor is computed for a region around the key point.

i) Assuming a SIFT descriptor is computed from a 16×16 image window around a key point, briefly describe how to find the dominant direction θ of the SIFT descriptor.

[3 marks]

ii) State two computer vision tasks or applications where SIFT is commonly used.

[2 marks]

c) Precision and recall measures are commonly used to evaluate classification performance. The confusion matrix below contains the performance of a 3-class image classification task, which predicts whether a photograph is taken with one of the 3 selected photographic styles; 'Landscape', 'Portrait' or 'Macro'.

<table>
<tr><td></td><td></td><td colspan="3">Predicted Lables</td></tr>
<tr><td></td><td></td><td>Landscape</td><td>Portrait</td><td>Macro</td></tr>
<tr><td rowspan="3">Actual labels</td><td>Landscape</td><td>880</td><td>20</td><td>100</td></tr>
<tr><td>Portrait</td><td>30</td><td>780</td><td>190</td></tr>
<tr><td>Macro</td><td>100</td><td>180</td><td>720</td></tr>
</table>

Compute the **precision** and **recall** of the 'Portrait' style.

[2 marks]

Continued...

Question 4

a) Assume you are given an image that suffers from the following problems related to image quality.
   - The image does not have enough contrast. Most areas in the image appear to be too bright.
   - The structures and boundaries in the image are blurred and thus it is hard to see the details of objects in the image.
   - There are random sparse black spots (pepper noise) that seem to be caused by some electronics noises.

You are asked to propose a system that use techniques you have learned in this class to improve the overall image quality. Design a conceptual diagram (flowchart of image processing processes) for a quality enhancement system that addresses all the problems mentioned above. Provide justifications for the use of each component and the specific order you adopt in combining different components.

[5 marks]

b) You have been assigned to come out with a vision-based solution for car park analytics. The solution should be able to extract information on car park traffic and occupancy for an open car park during office hours, from 9am to 5pm. The extracted information can then be used to provide useful analytics on the car park traffic and occupancy rate throughout the data. Assume a single outdoor video camera is being placed at a good location and angle that can capture the view of the whole care park.

Design a solution and provide the detailed steps to fulfill this task from the vehicle detection step, leading to the extraction of the required analytics.

[5 marks]

End of Paper